NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 119 AUGUST 2003

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

POSTCARD FROM KOREA

I have just returned from (South) Korea where I spent the last month. In this edition of *Catchword* I'd like to describe the impetus for my visit and some of my experiences.

Korea, sometimes referred to by westerners as the 'Hermit Kingdom', is well off the beaten track, hidden in some senses between the three powerhouse nations of China, Russia and Japan. It has a long and illustrious cultural history, but by the end of the Korean War in 1953 it was reduced to being one of the poorest nations in the world. Over the last three decades however it transformed into one of the four so-called 'Asian Tigers' and sustained stellar economic growth. Nowadays, it is a modern, technologically-sophisticated society with a highly skilled professional sector. Much of this success is due to a remarkably strong work ethic, a deep commitment (some might describe it as an obsession) to education, and active entrepreneurship. They are world leaders in ship building, automobile manufacturing, and the fabrication of computer chips and consumer electronics, amongst other things. They are one of Australia's top trading partners and there is increasing scientific, cultural and tourism exchange between our two countries.

The current population of South Korea is 48 million people, jammed into a space about the size of Tasmania. As well over half of the country is mountainous forest, you can begin to imagine how densely settled the cities and low-lying agricultural areas must be. The consequence of rapid development and crowding has been acute stress on the water resources of the country. Their chief problems are water shortages, flooding, poor water quality and degraded river condition. Sound familiar? Yes, their problems are very similar to our own. Three big initiatives underway in Korea are (i) plans to increase the available national water resource by 25% within the next ten years, (ii) the doubling of spillway capacity on their largest reservoir (Soyangang Dam) after a massive upward revision of the Possible Maximum Precipitation (PMP) estimate last year, and (iii) one of the largest urban river restoration projects in the world. In the latter project, a six km stretch of expressway in central Seoul overlying a buried, combined stormwater and sewerage system is being converted into a 'naturalised' channel with permanent flow to provide aesthetic, recreational and ecologic values.

Having recognised the gravity of their problems, the Korean Federal Government has recently made a significant funding commitment to water resources research. In 2001, the Sustainable Water Resources Research Center (SWRRC) was established for a 10-year period to undertake basic and practical research aimed at alleviating Korea's prime water resources problems. Like our own CRC, the SWRRC is a cooperative venture involving several research institutes, and has a structured plan for getting research results applied into practice. At the core of their agenda is a focus on catchment prediction and the development of integrated water resource system models. The SWRRC currently funds 21 projects to which they devote resources of about $15 million per year. By the end of their first year of operation, over 1000 scientists and over 600 students were involved in their research and development program. So, theirs is a large-scale undertaking on a topic area very closely aligned to ours.

My visit to Korea was supported by the Korean Federation of Scientific and Technological Societies and the SWRRC, based at the Korean Institute of Construction Technology in Seoul. For most of my time, I was hosted by Pusan National University, though I made multiple visits to Seoul and Taejon where several government departments are based. The purpose of my visit was to showcase the work of our Centre, to better understand the water resources research and development efforts of the SWRRC, and to stimulate research collaboration between our two organisations. It followed on from a week-long visit of an SWRRC delegation to Australia in February this year.

I and the Director of the SWRRC, Dr Kim Sung, have concluded that our CRC for Catchment Hydrology and the SWRRC have much to gain by working cooperatively, and have therefore agreed to undertake joint research and development in areas where we share common interests. By pooling our talents we can draw on a huge font of knowledge and attain the economies of scale required to undertake large, integrated modelling projects. SWRRC are doing some fabulous work in hydrologic data warehousing and spatial analysis that very strongly complements our Catchment Modelling Toolkit initiative. Various SWRRC researchers have expressed interest in the TIME modelling framework that underpins the Toolkit, as well as in several of the

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

CRC PUBLICATIONS LIST

A complete list of all documents and products produced by the CRC since 1993 is available at our web site at www.catchment.crc.org.au/ publications

Centre Office
CRC for Catchment Hydrology
Department of Civil Engineering
Building 60
Monash University Vic 3800
tel: 03 9905 2704
fax: 03 9905 5033
email: crcch@eng.monash.edu.au

Toolkit models such as MUSIC, EMSS and RAP. Having these models applied to the many demanding real-world applications in progress in Korea would be of huge benefit to our CRC.

Already we have some joint activity underway. Our Predicting Catchment Behaviour Program (Program 1) is helping researchers at Pusan National University apply our Rainfall-Runoff modelling Library to a set of Korean catchments. In December this year we expect one of the senior researchers from the SWRRC to arrive in Australia to undertake a sabbatical with our Centre. In the coming year we will jointly explore opportunities for co-developing models to suit our respective needs and to encourage their application in both countries. It is my hope that we will ultimately have a vibrant staff exchange program, underpinned by active sharing of expertise, data and models, and joint participation in research and development projects.

If you are interested in being involved in this collaboration, please let me know.

Rob Vertessy
Tel: (02) 6246 5790
Email: rob.vertessy@csiro.au

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Shane Seaton

All in good time - pathways and the canvas tool

Introduction

Hello friends, let me start with a half hearted apology for the title of this series. As we all know, TIME (The Invisible Modeling Environment) is the new model development framework for the toolkit project, and due to its unfortunate name, we are forced to throw around as many puns as possible. Again, sorry.

This is just the first of what should be many articles of a similar name and style. The purpose of these articles is to let you know how TIME is developing, and to publish some of the more interesting and useful features of the framework, in an attempt to entice you to become involved with the Catchment Modelling Toolkit.

This article gives a brief introduction to how Pathways was ported from ICMS (Interactive Component Modelling Tool) to TIME and the "Canvas" tool that was developed to support the creation of Pathways within TIME. As with many things developed within TIME both Pathways and the "Canvas" tool have the potential for much broader application.

Pathways

Pathways simulates the movement of sediment and attached pollutants from cropped hillslopes to streams. It enables the evaluation of the impact of alternative management measures including filter strips, contour banks (terraces) and constructed waterways on the sediment delivery processes. The model is intended to assist in the design of these measures for a particular environment using a design storm approach.

Pathways is designed for catchment engineers, planners, policy staff and managers in consultancies and state, regional and local government agencies.

The Pathways model was originally built by Tim Ellis in the ICMS environment. It was provided with six preconfigured scenarios for the same area of land. These six scenarios were run and compared against each other to asses the advantages of the above mentioned management measures. While the ICMS implementation of Pathways worked well, six scenarios were fairly limiting, and because of their fixed location, didn't provide users with any kind of 'ownership'.

TIME for a change

To bring Pathways to a wider audience, it was decided Pathways would be rebuilt into a stand alone application using TIME. The core science was extracted from the ICMS version and converted into TIME component models. This was a fairly simple exercise. The difficult part was developing a user-friendly interface.

One of the great aspects of ICMS is its ability to create node-link networks describing the interactions between models (nodes). This was definitely something we did not want to lose in the migration. The only concern with the node link system in ICMS was the way internal linkages between models were made. For the Pathways model this involved up to four or five linkages per model connection. This was too fiddly for the target audience of the model.

Taking this into consideration we created a "Canvas" tool for TIME, which allows users to drop on models and data, and to define relationships between them. While this did not remove the need to link the various internals of the models, it did give us the opportunity to create custom code to do the linking between models automatically. Creating custom link code was something ICMS did not readily provide.

After creation of the "Canvas" tool, we integrated it into a new interface and ended up with something having a similar look and feel to both ICMS and Program 4's MUSIC (Figure1.1).

Canvas Tool

Part of the design brief for TIME is that it should incorporate the best features from our existing model development systems, Tarsier and ICMS. With the addition of the "Canvas" tool and subsequent capability of linking models, we are moving much closer to achieving this goal.

The "Canvas" tool was created to be as generic as possible, so that it would be available to any application built with TIME. In fact, as with most components of TIME, incorporating the "Canvas" tool into your application is as easy as selecting it from a list of tools and dropping it onto you application's window at design time.

Early on in the design of the Toolkit, a need was identified for a tool that could link together arbitrary models and data in an easy manner, similar to that of ICMS. This concept, as it was proposed in TIME, was being called the Model Integration tool. Now, with the creation of the "Canvas" tool we are almost there.

As a proof of concept, Joel Rahman took it upon himself to write a simple tool that did exactly this (Figure 1.2). It is called the System Model Tool. Within an hour, he had a tool that produced a list of all the Models in TIME, all available for placement on a "Canvas". Once on that "Canvas", models could be linked together using simple drag-drop operations, and once linked, the internal connections (specifying exactly what data is passed between the models) could again be defined using drag-drop operations.

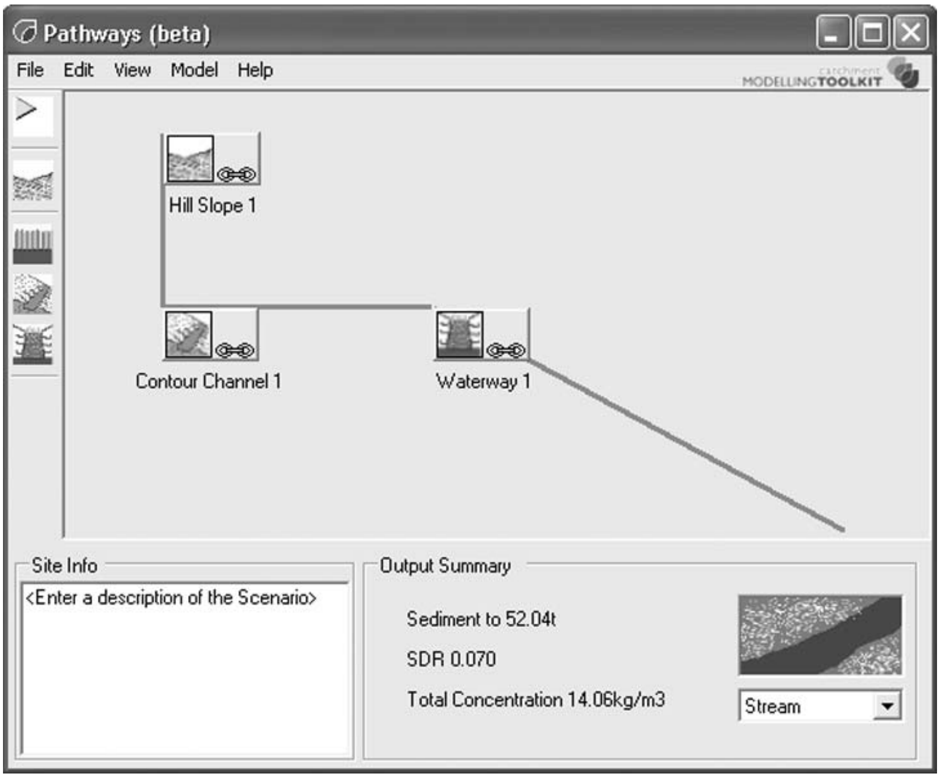

Figure 1.1 - The Pathways interface, as developed in TIME

www.toolkit.net.au

The Catchment Modelling Toolkit web site has been completely revised. The Toolkit web site will be used to deliver for the CRC for Catchment Hydrology's modelling software and supporting documentation over the next three years.

MUSIC users can now access a range of supporting information at www.toolkit.net.au/music

For further information visit www.toolkit.net.au

Comments and queries can be directed to
David Perry
tel: 03 9905 9600
email: david.perry@eng.monash.edu.au

CRC PROJECT PORTFOLIO (2003-2005)

The CRC has published a 'Project Portfolio' which gives readers an overview of the CRC, its mission and short summaries of all new CRC projects (2003-2005).

Copies can be obtained from the Centre Office by contacting Virginia Verrelli on 03 9905 2704.

The document can also be downloaded as an Adobe Acrobat .pdf file from our website at www.catchment.crc.org.au/news

For further information please contact David Perry on 03 9905 9600.

Shown below we have two screen shots. The first (Figure 1.2), from Joel's prototype tool, shows a simple composite model. Here we have a terrain analysis model (StreamDefine), which is used to create a subcatchment raster from a DEM. This subcatchment raster is then passed to another model (ExtractRaster) which extracts out a single subcatchment. The single subcatchment is then finally polygonised (Raster2Region), leaving us with a subcatchment outline for a single subcatchment. The second screen grab (Figure 1.3) shows the linking tool of the canvas, and how the StreamDefine model was set up to pass its subcatchment raster to the input of the ExtractRaster model.

While Joel's prototype is very basic, it does illustrate the possibilities of the proposed Model Integration tool. A more fully featured application might include entities such as databases and searchable model repositories. One particularly exciting idea is to have the composite model that is created, saved out as a model itself, allowing it to be brought back into the application as a single sub-model of a larger system.

Wind up

For further information on either the "Canvas" tool or the new Pathways model, don't hesitate to contact us here in Program 1.

Shane Seaton
Tel: (02) 6246 5825
Email: shane.seaton@csiro..au

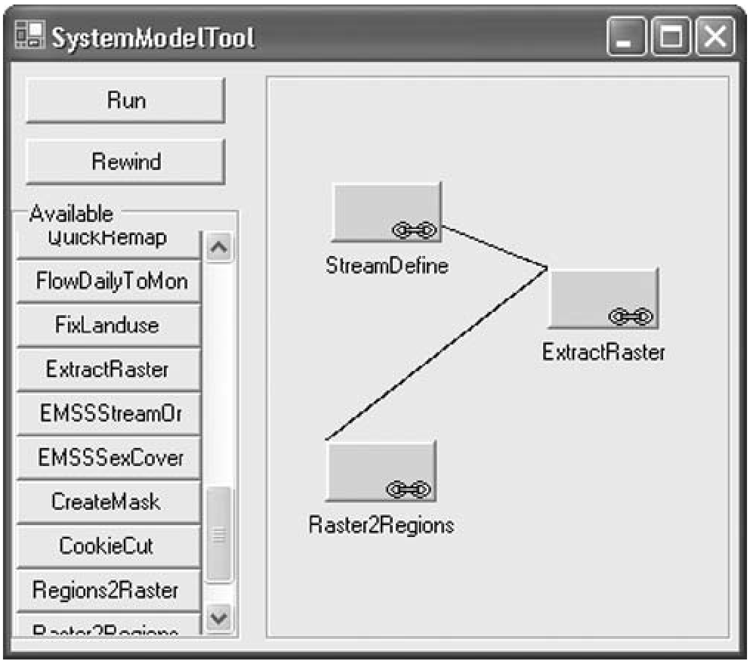

Figure 1.2 - Example of linking models together using the System Model Tool.

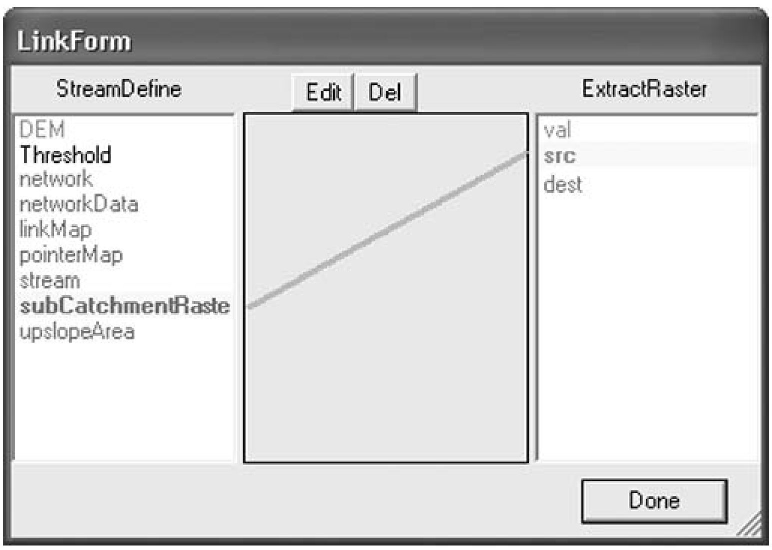

Figure 1.3 - Example of the "Canvas" tool's link editor.

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Our ability to consider multiple issues in decision support

Positive change in the landscape

In conversation over meals I observe myself building strong arguments for change based on other people's expertise. While I occasionally introduce some of my own research, the discussion is too broad to be sustained by the direct experience of the diners.

I, like most Australians, am interested in positive change in the Australian landscape. What I judge as "positive" is the sum of a series of outcomes for people and the environment. Natural resource management issues are complex and consider multiple issues. Our research, like our discussions, needs to reflect this reality.

Recently, there has been considerable debate in the media about the merits of new plantations for the Australian environment. Commentators have suggested the merits to regional economies, to river flows, to salinity mitigation and to the "fabric" of rural communities. The media tends to grab specialists' views and construct theatre through the apparent conflict between the specialist views.

CRC's role

The CRC's role is not just to provide expert comment on single issues. We must also provide some frameworks for balancing some of the considerations in decision-making. As we don't have all expertise relevant to a decision, we must remain decision-supporters, not decision makers.

Predictive approaches

Within this program we have several specialist predictive approaches to the consequences of land use change (e.g. converting a landscape dominated by annual pastures to one dominated by deep rooted perennial pastures). Through Project 2B: 'Improved suspended sediment and nutrient modelling through river networks', we can predict the consequences of this change for soil erosion and sorbed nutrient transport. Though Project 2C: 'Predicting salt movement in catchments' we can predict the resulting changes to salt movement. Through Project 2E: 'Modulating daily flow duration series to reflect the impact of land-use change' we can predict the reduction to stream flows. The planning of an actual change needs these models, and several other social and economic inputs, to be assembled in a structured way. Only then can we assess the net benefits.

The CRC's team has been aware of this need for some time. It is one of the driving forces of the Catchment Modelling Toolkit approach. We have made some progress in providing multi-criteria analysis for some land-use change decision. A major recent example is the Strategic Landscape Investment Model that was constructed between the (then) NSW Department of Land and Water Conservation, CSIRO Land and Water and the CRC for Catchment Hydrology. This prototype tool enables spatial layers of specialist's models to be combined to guide the setting of priorities in land-use change.

We have much to do to construct balanced reasoning for decisions to change the Australian landscape.

Peter Hairsine
Tel: (02) 6246 5924
Email: peter.harisine@csiro.au

OTHER OUTLETS FOR CRC PUBLICATIONS

In addition to the Centre Office, all CRC publications are available through the Australian Water Association (AWA) Bookshop in Sydney and the Department of Sustainability and Environment (DSE) Resource Centre in Melbourne. AWA and DSE also stock a wide range of other environmental publications.

AWA Bookshop (virtual)
contact Diane Wiesner
Bookshop Manager
tel: 02 9413 1288
fax: 02 9413 1047
email: bookshop@awa.asn.au
web: www.awa.asn.au/bookshop/

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Open: 8.30-5.30, Monday to Friday

WEATHER RADAR CONFERENCE

Sixth International Symposium on Hydrological Applications of Weather Radar

2-4 February 2004
Melbourne, Australia

The major theme of this conference is 'The successful implementation of radar technology for hydrological and quantitative rainfall applications'.

For more information on the symposium, please visit www.bom.gov.au/announcements/conferences/hawr2004 or email hawr2004@bom.gov.au

The conference is supported by the Commonwealth Bureau of Meteorology, the CRC for Catchment Hydrology and the Australia Meteorological and Oceanographical Society

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Bringing Industry Models into the Laboratory

Project 3B (3.09): 'An evaluation of permanent water markets' is entering into an exciting phase. Following the development of Mwater in Project 3.2, this project is developing laboratory environments:

(a) calibrated on focus catchments for exploring alternative market institutions for water trading,

(b) to explore markets for point and non-point pollution and other water quality markets,

(c) to explore property right options for environmental traders, and

(d) to evaluate alternative property right and institutional rules for ecosystem services markets.

Calibration of Mwater for the Murrumbidgee Catchment
Researchers in Project 3A (3.08): 'Hydrologic and economic modelling for water allocation' have worked with industry to aggregate the Murrumbidgee IQQM model into a 12 node conceptual model for integration into the Mwater experimental environment. Mwater has been populated with the data and trial experiments are underway. Over the next few months alternative institutional structures will be evaluated in the laboratory using Mwater-IQQM.

Pollution and Water Quality Markets
The Environmental Management Support System (EMSS) was developed by researchers in Program 1 for managing runoff and associated suspended sediment, nitrogen and phosphorous in South East Queensland. Possible market structures are being explored for trading in sediment and water quality. EMSS is being used to populate the experimental setting. Trial experiments exploring markets for total suspended solids based on data from the Stanley Catchment are underway.

Markets for Instream Flows
There are a number of policy options for the management of instream flows including direct acquisition, cap and trade and allowance for environmental traders. In conjunction with Environment Australia, researchers are exploring these options and developing laboratory environments to evaluate alternative property right and institutional structures.

Ecosystem Services Markets
Outside the immediate project, but as part of planning for the future, work is underway on developing valuation techniques and markets for ecosystem services.

Ecosystem services valuation is a relatively new concept in natural resource management, and literature on the topic is expanding rapidly. What is of interest is to value the changes in quality or quantity of different types of natural capital and ecosystem services that may have an impact on human welfare.

Ecosystems are complex systems that can be characterised as being highly non-linear and at times subject to quick or irreversible changes. Ecosystems appear to be able to maintain themselves in stable states, where there is a multiple of equilibriums that are described by non-linear functions. In other words, ecosystems are autopoetic, self-organising entities. Systems can, however, flip from one state to another (bifurcations) and this change is unpredictable, non-linear and often irreversible. These irreversible bifurcations can have major impacts upon ecosystem services and their role in the economy. Therefore managing ecosystem services for a long-term sustainability requires that the complexity of these systems be taken into account. Developing appropriate property right and institutional structures for trading the services arising from ecosystems is therefore not a simple task, but a task well suited for the laboratory. As a first step, work is currently underway in a CRC Associated/Additional project to provide some first-cut values on replacing the ecosystem services of the mid-Brisbane catchment.

Project 3B has some quite exciting projects underway and we look forward to linking with other researchers and industry bodies with interest in this field.

John Tisdell
Tel: (07) 3875 5291
Email: j.tisdell@mailbox.gu.edu.au

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader

TIM FLETCHER

Report by Tim Fletcher and Tony Wong

The Launch of Australian Runoff Quality (the birth of AR&R's baby sister)

Background

Most regular readers of the Urban Stormwater Quality articles in *Catchword* would be aware of the seminal text entitled "Australian Rainfall & Runoff" (AR&R). Launched by the Institution of Engineers Australia in 1958, and most recently updated in 1999, AR&R provides guidance on flood estimation in Australia.

In 2001, the Institution's National Committee on Water Engineering decided that a sister-volume, dealing with the management of runoff quality, was required to guide Australian practice in the pursuit of environmentally-sensitive stormwater management. At this time, "Australian Runoff Quality" (ARQ) was simply a twinkle in its parents' eye. Like any worthwhile exercise, however, the gestation period between the idea being conceived, and the result being born, has been long and effort-consuming.

Led by Assoc. Prof. Tony Wong as Editor-in-Chief, a team of authors, pre-eminent in their respective fields, and including several current and former researchers from the CRC for Catchment Hydrology and CRC for Freshwater Ecology, was co-opted. The authorship team met several times throughout the process, including a final two-day meeting, spanning well into a weekend. This (entirely voluntary) commitment from the authors, who came from government, academia and the consulting industry, is a symbol of their dedication to improving stormwater management in Australia.

Purpose of Australian Runoff Quality

The overall purpose of ARQ is to provide:

- Procedures for the estimation of a range of urban stormwater contaminants;
- Design guidelines for commonly applied stormwater quantity and quality management practices;
- Procedures for the estimation of the performance of these practices; and
- Advice with respect to the development of integrated water cycle management practices.

Australian Runoff Quality is not a technical manual, and will need to be used in conjunction with design manual and standard design specifications from State and/or Local Government Authorities, based on local terrain, geological and climatic conditions.

ARQ contents

There are thirteen chapters in Australian Runoff Quality:

<u>Chapter 1 - Introduction (by Tony Wong):</u> describes the purpose and scope of Australian Runoff Quality, and provides an introduction to the concepts of Water Sensitive Urban Design, and its context within Ecologically Sustainable Development. It also introduces the concept of urban water management objectives, in terms of reduction of urban water supply demand, stormwater management, and wastewater management. Lastly, the chapter outlines mechanisms for assessing the performance of urban water cycle management strategies.

<u>Chapter 2 - Stormwater pollutants, processes and pathways (by Peter Breen & Ian Lawrence):</u> this chapter commences with a summary of major urban water and stormwater management studies, in order to explain the concepts of values and uses of waterways, and major management issues for urban waterways. The chapter then outlines the characteristics of stormwater pollutants, along with their sources, mobilisation and transport pathways. The chapter concludes with a section that relates pollutant characteristics and processes to stormwater management requirements.

<u>Chapter 3 - Urban stormwater pollutant concentrations and loads (by Hugh Duncan):</u> provides a summary of observed stormwater quality, for a range of parameters, including suspended solids, phosphorus, nitrogen, chemical and biochemical oxygen demand, oil and grease, total organic carbon, pH, turbidity, heavy metals, several pathogen indicators, and gross pollutants. The chapter also summarises the processes which determine stormwater quality, and provides advice on appropriate approaches when little stormwater quantity or quality data are available.

<u>Chapter 4 - Water sensitive urban design (by Mike Mouritz, Marino Evangelisti & Tony McAlister):</u> this chapter outlines the concept of Water Sensitive Urban Design (WSUD), and what it aims to achieve. Policy and planning frameworks to support WSUD are described, along with the treatment train approach to stormwater management. Practical advice on the implementation of WSUC is provided, including site analysis, land capability assessment, integration of public open space, house and road layout, and streetscaping. Importantly, the chapter describes the

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - An Overview of their Use, Value, Cost and Evaluation

By

André Taylor
Tony Wong

Technical Report 02/11

This report presents an overview of a CRC project co-funded by EPA Victoria that investigated the use, value, life-cycle costs and evaluation of non-structural best management practices (BMPs) for improved urban stormwater quality and waterway health.

The report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Survey Investigating their Use and Value

By
André Taylor
Tony Wong

Technical Report 02/12

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report documents and analyses the findings of a detailed survey of 36 Urban Stormwater Managers from Australia, New Zealand and the United States.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

interdisciplinary approach needed to achieve WSUD, and finishes eleven case studies which illustrate the implementation of WSUD across a wide range of situations.

Chapter 5 - Roofwater, stormwater and wastewater re-use (by Peter Coombes, Grace Mitchell & Peter Breen): introduces the concept of roof and stormwater harvesting as a source control. It describes the important process of matching end-use to the quality of water harvested. Utilisation of roofwater using rainwater tanks is discussed in detail, with costs provided. Watewater and greywater reuse are also discussed, with advice provided on the expected quality of water from these sources. A summary of guidelines and regulations is provided, along with a framework for assessing risks.

Chapter 6 - Water quality criteria guiding the selection and design of stormwater management measures (by Ian Lawrence & Brett Phillips): this chapter provides guidance in the process of linking receiving water quality guidelines to stormwater management targets. A detailed process is provided for application of sustainable catchment discharges to local project requirements, and a case study is provided.

Chapter 7 - Gross pollutant and sediment traps (by Robin Allison & David Pezzaniti): describes the role of gross pollutant traps (GPTs) as part of the treatment train. It provides very useful advice for specifying GPT performance, including information on site constraints, treatment objectives, operating design flows, and maintenance requirements. A summary of the types of GPTs is provided, along with a description of their mode of operation. Lastly, a selection guide is provided, including installation and maintenance costs and considerations.

Chapter 8 - Hydrocarbon management (by Brett Phillips & Ian Lawrence): describes management strategies for reducing the threat of hydrocarbons to receiving waters. The chapter describes the type of hydrocarbon treatment measures, along with their maintenance requirements, and provides guidance on their selection.

Chapter 9 - Buffer strips, vegetated swales and bioretention systems (by Tim Fletcher, Tony Wong & Peter Breen): this chapter describes three related stormwater treatment measures - buffer strips, vegetated swales and bioretention systems. The chapter outlines their mode of operation, design requirements, and expected water quality treatment performance. Worked examples are provided to illustrate the design process, for a range of site constraints and requirements. Photographs of a range of these measures are provided.

Chapter 10 - Infiltration systems (by John Argue & David Pezzaniti): this chapter provides detailed guidance on the application of infiltration systems for controlling stormwater quantity and quality. Background theory is provided, along with four detailed design procedures. Advice is also given on design issues for infiltration systems, including flood control, lifespan and maintenance requirements.

Chapter 11 - Constructed wetlands and ponds (by Peter Breen, Tony Wong & Ian Lawrence): chapter 11 provides a thorough description of the application of two of the most-widely applied stormwater treatment measures in Australia - constructed stormwater treatment wetlands, and ponds. The chapter describes the difference between the two systems, and provides guidance on their selection. Treatment processes are described in detail, along with advice on how to promote the effective use of each process to reduce target pollutant concentrations. Design considerations are discussed in detail, including appropriate sizing, location, use of a 'treatment train' approach, and measures of effectiveness. The role of vegetation is discussed, together with expected water quality performance.

Chapter 12 - Urban waterways (by Ian Lawrence & Peter Breen): this chapter discussed the values of urban waterways, and the factors affecting their ecosystem health (including hydrology, hydraulics, water and sediment quality, riparian vegetation, and biological passage. Planning, management and design considerations are discussed, along with maintenance requirements. Maintenance considerations are also described.

Chapter 13 - Modelling urban stormwater management systems (by Tony McAlister, Grace Mitchell, Tim Fletcher & Brett Phillips): increasing use of modelling techniques for the planning, design and evaluation of stormwater treatment strategies means that guidance on appropriate modelling techniques is required. The final chapter of ARQ describes appropriate applications of stormwater models, and discusses in detail factors that should be considered before undertaking modelling. These include the purpose of modelling, the temporal and spatial scale, and calibration techniques. A guide to good modelling practice is also provided. There is a brief review of commonly available stormwater quality modelling packages - and it is intended that this list of packages be expanded, prior to publication of the final version of ARQ in 2004.

Your chance to contribute

The draft of Australian Runoff Quality was released in June 2003, at a two-day symposium, held in Albury. With the release of the draftt version of Australian Runoff Quality, the consultation process, overseen by Engineers Australia (formerly the Institution of Engineers Australia) has now begun.

The entire ARQ contents are available for download (as Adobe Acrobat pdf files) from the ARQ website (www.arq.org.au). A standard feedback form can also be completed on that website.

Users of the draft version of ARQ are encouraged to comment on the document, so that the final version (due for release in July 2004) best suits the needs of Australian industry and practice.

Tim Fletcher
Tel: (03) 9905 2599
Email: tim fletcher@eng.monash.edu.au

Tony Wong
Tel: 0403 438 323
Email: tony.wong@eng.monash.edu.au

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Literature Review of their Value and Life-cycle Costs

By

André Taylor
Tony Wong

Technical Report 02/13

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report presents the findings of a literature review on the value and life-cycle costs of non-structural BMPs to improve urban stormwater quality.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

NATIONAL CONFERENCE ON INTEGRATED CATCHMENT MANAGEMENT (ICaM - 2003)

26-27 November 2003
Parramatta, NSW

ICaM - 2003 aims to bring together practising scientists, engineers, policy makers, community educators and academics in the field of environment and catchment management.

Case studies from around Australia are especially encouraged, providing delegates with opportunity to share their problems and solutions with the wider water resource community.

For further information about contributing papers or attending please email your query to icam2003@awa.asn.au

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Francis Chiew

Simulation of climate change impact on runoff using a simple daily scaling method for producing rainfall scenarios that consider daily patterns of change from GCMs

Global warming and climate change impact

There is now strong evidence that global warming - caused by increases in greenhouse gas concentrations - is occurring. The global warming will lead to changes in precipitation pattern and other climate variables. Changes in precipitation are almost always amplified in runoff. Higher temperatures and potential evapotranspiration may lead to a reduction in runoff and soil moisture levels.

Many water authorities are starting to take into account the climate change impact on land and water resources design and management. As there are large uncertainties in climate change prediction, the policies related to long-term management should not be based on a particular prediction, but instead should focus on policy alternatives that make sense for a wide range of plausible climatic conditions.

This article presents a relatively simple method that can be used to obtain greenhouse-enhanced climate scenarios which consider daily patterns of change from global climate models (GCMs). These scenarios can be used to simulate climate change impact on runoff. Because the method is relatively simple, the uncertainty in climate change scenarios can be considered by running a hydrological model with scenarios obtained from different GCMs for different global warming projections.

Estimation of climate change impact on streamflow

The potential climate change impact on runoff (and hydrological variables) is commonly estimated by comparing the runoff simulated by a hydrological model using present climate data and using future climate change scenarios predicted by GCMs. The parameters in the hydrological model are optimised against historical streamflow data, and the same model parameter values are used for simulations for the present climate and the greenhouse-enhanced climate.

The biggest uncertainty in estimating climate change impact on streamflow is in the estimation of the climate change scenarios. This is because the climate system is governed by many interrelated factors, and the change in climate variables, particularly rainfall, is difficult to estimate reliably. The main uncertainties are in the projection of greenhouse gas emission, estimation of the change in the radiative balance of the atmosphere resulting from increased greenhouse gas concentration (climate sensitivity), and GCM modelling of the climate system.

The best source of climate change projections for Australia is CSIRO Atmospheric Research (www.dar.csiro.au/publications/projections2001.pdf). The CSIRO considers the range of IPCC (Intergovernmental Panel on Climate Change) scenarios of global warming resulting from different scenarios of greenhouse gas emission and climate sensitivity, and simulations from various GCMs, to estimate the plausible range of changes to Australian rainfall and temperature.

There is also a smaller but potentially important uncertainty in the hydrological modelling approach. The use of the same model parameter values to simulate both the present climate and the greenhouse-enhanced climate assumes that the catchments and hydrological processes continue to behave as they do at present. Potential feedbacks between the surface and the atmosphere are also not taken into account. Some research groups are starting to model vegetation as a dynamic component in coupled atmospheric and hydrological models in an attempt to more reliably quantify climate change impact.

Reflecting climate change in rainfall data

To model climate change, the historical climate data are modified to reflect the changes estimated by GCMs in a future climate. The simplest method for reflecting climate change in the input data is to increase the historical temperature, and scale the observed catchment rainfall by changes estimated by GCMs. This is by far the most commonly used method where a constant factor for each month or season is used to scale all the daily rainfall in the month or season. Because this method is simple, the uncertainty in the climate change scenarios can be easily considered by running the hydrological model with scenarios obtained from many different GCMs for various climate sensitivities and greenhouse gas emission. The main limitation of this constant scaling method is that it ignores the changes in the temporal distribution and the magnitude and frequency of rainfall events.

To overcome this limitation, the stochastic weather generator and stochastic downscaling approaches can be used. However, considerably more effort is required to use the stochastic methods because relationships must be established between the historical catchment rainfall and GCM estimates of present and future rainfall or atmospheric variables. Because of this, most studies that use stochastic methods consider results from only one GCM simulation, and therefore do not take into account the range of uncertainties in the climate change scenarios.

An alternative approach is the daily scaling method where the pattern of change in the ranked GCM daily rainfalls is used to scale the ranked historical catchment daily rainfalls. Figure 5.1 illustrates the method for January rainfall for the East Victoria grid simulation from the CSIRO Mark 2 GCM for a medium CO_2-growth scenario and rainfall in a 150 km^2 catchment (Rose River at Matong North). The ranked GCM daily rainfalls for 1961-1990 (Figure 5.1a) and for 2021-2050 (Figure 5.1b) are compared and the ranked differences are expressed as ratios relative to 1961-1990 values (Figure 5.1c). The ranked daily pattern of change in GCM rainfalls (Figure 1c) is then used to scale the 98 years (1901-1998) of ranked historical catchment daily rainfalls (Figure 5.1d) to provide 98 years of daily catchment rainfalls in a 2021-2050 climate (Figure 5.1e). The 98 years of 2021-2050 daily catchment rainfalls have the same temporal structure as the present rainfalls, but a different factor is used to scale the different rainfall amounts.

Simulation of climate change impact on runoff

Figure 5.2 compares the simulated runoffs for 2021-2050 and 1961-1990 climates for the above 150 km^2 catchment in south-east Australia. The modelling is carried out using the daily conceptual rainfall-runoff model SIMHYD with historical rainfall and potential evapotranspiration data from 1901-1998. To reflect climate change, the historical catchment rainfall is scaled by the changes estimated by the CSIRO Mark 2 GCM using both the constant scaling method and the daily scaling method. Figure 5.3 shows the modelling results for a 100 km^2 catchment in south-west Australia (Thomson Brook at Woodperry Homestead).

The results indicate that it is important to take into account the different changes to the different rainfall amounts in climate change impact studies. This is because although the GCMs generally show a decrease in the mean annual rainfall in south-east and south-west Australia, they estimate an increase in the extreme daily rainfall. Taking into account the increase in the heavier runoff-producing events (daily scaling method) results in a smaller decrease in the mean annual runoff compared to scaling all the daily rainfall by the same factor (constant scaling method). The increase in extreme daily rainfall also translates to an increase in extreme daily runoff (see winter values in Figure 5.2) or a smaller decrease in extreme daily runoff compared to the decrease in mean annual runoff (see Figure 5.3). This may also have implications on catchment processes relating to extreme runoff events like erosion and sediment generation.

The daily scaling method is a simple approach that can be used to scale historical catchment rainfall to reflect changes in the different rainfall amounts simulated by GCMs. Because this method is still relatively simple, the uncertainty in the climate change scenarios can be considered by running the hydrological model with scenarios obtained from different GCMs for various global warming projections.

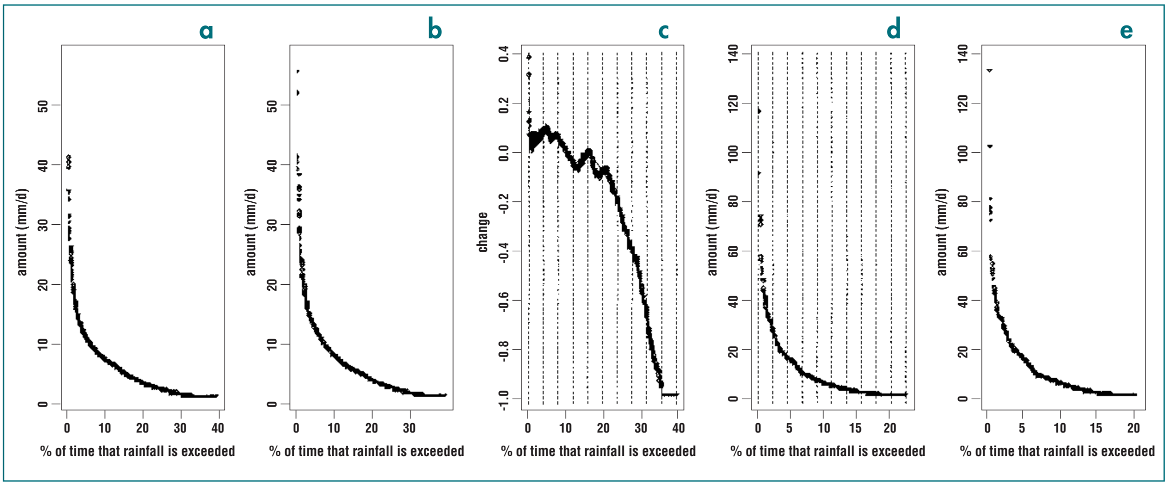

Figure 5.1 Illustration of the daily scaling method for January rainfall for south-east Australia. (a) ranked GCM daily rainfall for 1961-1990, (b) ranked GCM daily rainfall for 2021-2050, (c) pattern of change in ranked GCM daily rainfall, (d) ranked catchment daily rainfall (over 1901-1998), (e) scaled catchment daily rainfall to reflect 2021-2050 climate

NEW TECHNICAL REPORT

Evaluation of Two Daily Rainfall Data Generation Models

by
Lionel Siriwardena
Ratnasingham Srikanthan
Tom McMahon

Technical Report 02/14

This report evaluates the Transition Probability Matrix model with Boughton's correction for interannual variability (TPM) and the simplified Daily and Monthly Mixed (DMMS) model for the generation of daily rainfall data. The report also compares the statistical characteristics of the daily, monthly and annual streamflow data simulated by a rainfall-runoff model using stochastic daily rainfall obtained using the TPM and DMMS models with the historical streamflow characteristics.

Printed and bound copies of this report are available from the Centre Office for $27.50 (includes GST, postage and handling).

Centre Office
tel 03 9905 2704
fax 03 9905 5033
email crcch@eng.monash.edu.au

www.toolkit.net.au

The Catchment Modelling Toolkit web site has been completely revised. The Toolkit web site will be used to deliver for the CRC for Catchment Hydrology's modelling software and supporting documentation over the next three years.

MUSIC users can now access a range of supporting information at www.toolkit.net.au/music

For further information visit www.toolkit.net.au

Comments and queries can be directed to
David Perry
tel: 03 9905 9600
email: david.perry@eng.monash.edu.au

References

Chiew, F.H.S., Harrold, T.I., Siriwardena, L., Jones, R.N. and Srikanthan, R. (2003) Simulation of climate change impact on runoff using rainfall scenarios that consider daily patterns of change from GCMs. Proceedings of the International Congress on Modelling and Simulation (MODSIM 2003), Townsville, July 2003, (ISBN 1-74052-098-X), Volume 1, pp. 154-159.

Harrold, T.I. and Jones, R.N. (2003) Generation of local-scale rainfall scenarios using changes in GCM rainfall: a refinement of the perturbation method. Proceedings of the International Congress on Modelling and Simulation (MODSIM 2003), Townsville, July 2003, (ISBN 1-74052-098-X), Volume 1, pp. 11-16.

Francis Chiew
Tel: (03) 8344 6644
Email: fhsc@unimelb.edu.au

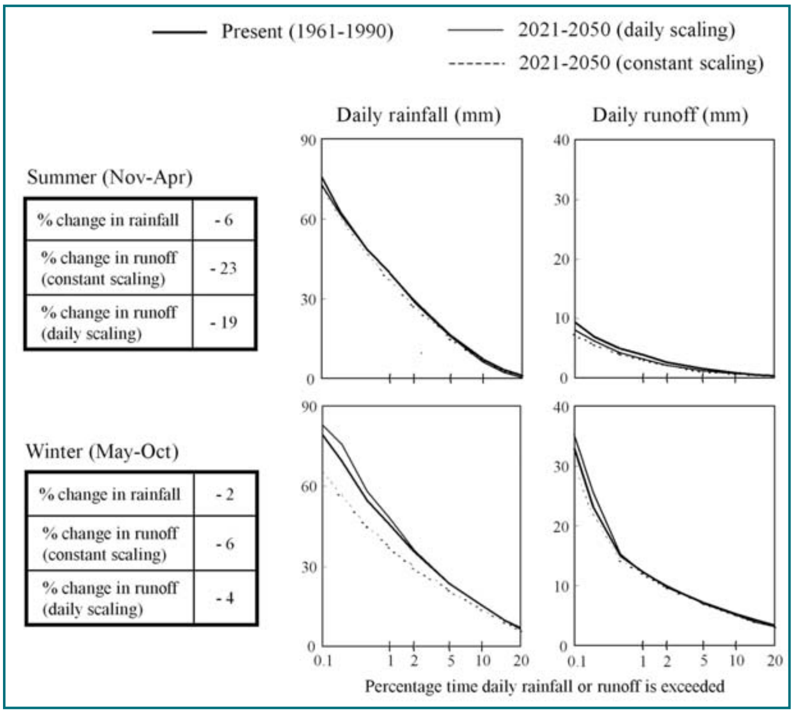

Figure 5.2 Simulated rainfall and runoff for 2021-2050 compared to present rainfall and runoff (1961-1990) for south-east Australia

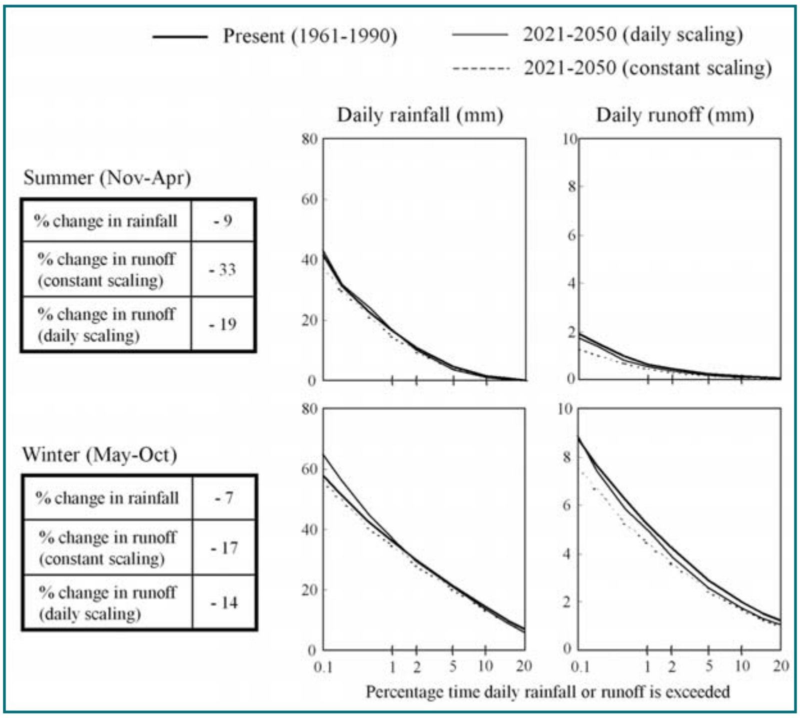

Figure 5.3 Simulated rainfall and runoff for 2021-2050 compared to present rainfall and runoff (1961-1990) for south-west Australia

PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Ian Rutherfurd

Wrap-up of the initial River Restoration projects

After almost three years, the initial River Restoration projects are drawing to a close, and transmogrifying into Projects 6A (6.11): 'Development of flow-ecological response models' and 6B (6.12): 'Predicting spatial and temporal variations in channel form' under the Program leadership of Mike Stewardson.

Unlike other projects in the CRC for Catchment Hydrology, the River Restoration Program concentrated on planning and process-scale issues, rather than catchment scale modelling. This was a deliberate strategy, since many of the stream rehabilitation issues at present are still local in scale. The goal of the program was to "provide tools to stream managers to increase their confidence in stream rehabilitation". You should visit the Project Website to find out more about all of the projects and results, and to find more detailed publications from the Program.

It is hard to summarise the results of many complex activities involving up to eight researchers, and more than a dozen post-graduate students, and numerous summer students. So instead, I will summarise the research in a series of questions and answers, giving the project and some of the people responsible for the answers. It is a common misconception amongst managers that good research makes management simpler. This is not always the case. Research, particularly in stream rehabilitation, often shows how we had underestimated how complex things were.

Planning project evaluation

(Project 6.1: Developing criteria and concepts for planning the evaluaton of stream rehabilitation projects and 6.2: Optimising urban stream rehabilitation planning and execution)

- Surely we should evaluate whether all stream rehabilitation projects have worked? Definitely not. There needs to be a clear hierarchy of evaluation methods when people alter flows, revegetate, or do other 'rehabilitation' activities. Such a hierarchy has been produced by Project 6.1 (Ian Rutherfurd, Tony Ladson, Mike Stewardson). In fact, there are many good reasons not to evaluate how effective an intervention has been.
- By looking at revegetation projects of the past, we must be able to learn something? Unlikely. Looking at over 80 riparian revegetation projects in NE Victoria, we conclude that the projects are all so different that we can learn very little from them. Instead we have to start afresh with a properly designed riparian experiment, which is now being initiated by the MDBC in a joint CRC for Freshwater Ecology and CRC for Catchment Hydrology project (Michelle Ezzy, Ian Rutherfurd).

Pathways (trajectories) of recovery of damaged streams

(Projects 6.3: Restoration ecology in the Granite Creeks, Victoria and 6.4: Evaluation of riparian revegetation in a south-east Queensland catchment).

- Many streams have filled with sand, if we wait long enough won't the sand all flush through and the stream recover? It depends. Using a novel space-for-time approach, Rebecca Bartley, in her PhD, looked at three sand slug systems in detail. Gravel bed streams appear to recover almost completely, whereas for many incising streams the sand simply represents a hiatus of incision.
- Will riparian re-vegetation lead to improved water quality in small streams? When Nick Marsh revegetated the riparian zone of a small sub-tropical stream in Queensland, he did not predict the dramatic decrease in water temperature it produced. He did predict the early increase in turbidity that we have observed as grass is replaced by trees.

Improved design of rehabilitation tools

(Projects 6.3, 6.5, 6.6, 6.7)

Project 6.3: Restoring Granite Creeks.

- Does adding logs to a uniform sand bed stream lead to any recovery? Yes. Joint sampling with the CRC for Freshwater Ecology has shown that there is a strong relationship between pool-depth and fish numbers and diversity. However, this project has led us to develop a 'stochastic' model of recovery that expresses the biological effect of the log (or any intervention) in probabilistic terms. To test this approach we have also developed a novel method (pressure-transducer) for continuous measurement of bed fluctuation (Masters project by Dan Borg). Dan is now deploying this tool in the Snowy River.

Project 6.5: Hydraulic design of fishways (part funded by Agriculture, Fisheries and Forestry, Australia).

- Vertical slot fishways on large dams cost millions of dollars. Surely we understand the hydraulics of these structures since we are now building so many of

NEW SOFTWARE - CHUTE

www.toolkit.net.au/chute

CHUTE carries out the hydraulic design of rock chutes for stabilising channel beds and is designed for use by professional engineers and managers involved in stream rehabilitation and restoration.

CHUTE is the first of many products that will be available to the land and water industry via the Catchment Modelling Toolkit website at www.toolkit.net.au

CHUTE will be able to be downloaded from the Toolkit Members area during early September 2003. Registered members will receive an email announcing its availability.

For further information including copies of the Rock Chute Design Guidelines, please visit www.toolkit.net.au/chute

URBAN STORMWATER SOFTWARE

MODEL FOR URBAN STORMWATER IMPROVEMENT CONCEPTUALISATION (MUSIC)

MUSIC is a decision-support system. The software enables users to evaluate conceptual designs of stormwater management systems to ensure they are appropriate for their catchments. By simulating the performance of stormwater quality improvement measures, music determines if proposed systems can meet specified water quality objectives.

MUSIC is available from the Centre Office for $88.00

Individuals will need to sign a Licence Agreement (available from the Centre Office and website: www.catchment.crc.org.au)

For further information contact the Centre Office on 03 9905 2704 or email crcch@eng.monash.edu.au

Please note: MUSIC version 1.00 is a development version and will be valid until September 2003. The CRC for Catchment Hydrology is committed to updating MUSIC annually until at least 2006. Subsequent versions of MUSIC may be charged for.

them? We certainly understand a lot more about them after the first comprehensive hydraulic analysis carried-out by Lindsay White for his PhD (under the supervision of Bob Keller). Out of this work will come rules for optimising the design of pathways.

- Should we build more low gradient fishways because swimming ability of Australian fish limits the success of fishways? Lindsay White's PhD thesis on fishways shows that there are numerous factors that control the success of fishways on the Murray River. Simple velocity and swimming ability is only one of them. Slower velocities in the fishway may, at some point, be less attractive to fish.

Project 6.6: Scour of rehabilitation structures.

- Rock chutes will fail at by scour at maximum flood stage. False. Rock chutes, one of the major stream rehabilitation methods, fail at floods of moderate magnitude, and by many different mechanisms. Some of the design rules are expressed in a new software package for designing rock chutes (Chute) that is available from Bob Keller and Tony Ladson.

Project 6.7: Environmental flow methods.

- How does a manager optimise the environmental outcomes from available water for environmental flow releases? The manager simply uses the 'Flow Events Method' developed by Mike Stewardson Mike Stewardson [mjstew@unimelb.edu.au]. The method has been used with great success in designing environmental flow regimes for the Loddon and Goulburn Rivers in Victoria.

Project 6.10: Methods for estimating roughness.

- Many professionals involved in river work need to estimate roughness coefficients. Surely there is an up-to-date standard for doing this for Australian streams? No. There has been little advance in the professional approach to this problem in Australia since the 1960s. Under the direction of Tony Ladson (tony.ladson@eng.monash.edu.au), we have developed a hierarchical approach to estimating roughness in Australian streams using equations and pictures.

The next round

For the last three years the River Restoration Program has concentrated on planning and developing tools. The next round of the Program, under the direction of Mike Stewardson, will incorporate the planning advances into the Catchment Modelling Toolkit. The specific emphasis of the new projects 6A and 6B, will be environmental flows.

Ian Rutherfurd
Tel: (03) 8344 7123
Email: idruth@.unimelb.edu.au

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect – August 2003

Report by Bob Keller and David Perry

At a glance – a summary of this article

This month's article provides details of the CHUTE software - the first of many CRC products to be delivered via the Catchment Modelling Toolkit website (www.toolkit.net.au/chute).

Rock chutes

A rock chute is a relatively short and steep section of the bed of a channel which has been armoured with rock. It is normally intended to either stabilise an erosion head, preventing it from moving upstream in the channel, or to reduce the overall grade of a channel by providing a weir within the channel bed.

Although the concept of a rock chute is simple, proper hydraulic design is very important to ensure that the chute geometry and rock size are matched with the expected flow conditions such that the rock remains stable under all expected flow conditions. In addition, appropriate rock chute design requires that the abutments are treated to prevent failure by outflanking of the crest and that the grading of rock sizes within the rock mixture minimises the presence of voids.

CHUTE software

As part of the River Restoration Program, Bob Keller, Frank Winston and Tony Ladson (Monash University) with assistance from John Tilleard and Ross Hardie (Earth Tech Pty. Ltd.), have recently completed the development of the CHUTE software - a hydraulic design program for the design of rock chute structures used for stabilising river and stream beds. This new version of CHUTE (v. 1.0.0) has been developed as a design tool from an earlier DOS-based version of the same name, produced by Ian Drummond and Associates (now Earth Tech Pty. Ltd) in 1989 under contract to the State Rivers and Water Supply Commission of the State of Victoria.

Using CHUTE

The CHUTE program is designed for use by engineers in Catchment Management Authorities, Local Government Organisations, and consulting practices who are involved in river and stream rehabilitation and restoration studies. It allows a number of different chute layouts to be quickly and efficiently designed. A major advantage of the new software is that it identifies the critical flow rate, with respect to the chute design, which is often substantially lower than the maximum design flow rate. The program calculates the required stone size throughout the prescribed flow range and provides detailed design information at the identified critical flow. The user selects a downstream boundary condition from a range of options.

With its user-friendly interface and supporting documentation, CHUTE is very easy to use. It is, however, a design tool and, for informed application of the program, users should have a sound knowledge of basic river hydraulics, including concepts of flow profile calculation, mechanisms of bed instability, and gradient control. Many chutes fail for reasons other than inadequacies in their specific hydraulic design. Such failures are often related to poor understanding of the prevailing site conditions such as hydrology, overall stream morphology, floodplain and channel hydraulics, and foundation conditions.

Rock Chute Design Guidelines and a word of caution

To support the use of the CHUTE software, Bob Keller has written a publication entitled 'Guidelines for the Design of Rock Chutes using CHUTE'. The guidelines describe the program CHUTE and its proper use to design and analyse the performance of a chute under a range of flow conditions. Other important aspects of rock chute design including rock gradation, filter design, cutoff wall and crest design, and protection against outflanking are briefly discussed in the Design Guidelines but are not part of the CHUTE software. These aspects are included for guidance only and practitioners will acknowledge the importance of accessing local knowledge and experience with other chutes on the same stream or under similar conditions. Finally the guidelines' appendix details the hydraulic theory underpinning the program CHUTE.

The CHUTE software and user support

Potential users of the CHUTE software will be able to download the program from the Catchment Modelling Toolkit web site at www.toolkit.net.au/chute during early September 2003. Further details of the CHUTE program including system and input requirements, output features, the guidelines and relevant publications are now available at the CHUTE home page web address given above.

CHUTE users also have their own e-group (discussion list) and you are invited to join the group at http://mail.toolkit.net.au/mailman/listinfo/chute The purpose of the e-group is to encourage discussion about any aspect of CHUTE or its use among users and others

CATCHMENT MODELLING SCHOOL 9-20 February 2004

The CRC for Catchment Hydrology is proposing to hold a Catchment Modelling School during 9-20 February 2004 in Melbourne, Victoria.

The workshop based School aims to equip participants with the skills required to undertake and interpret a range of modelling activities relevant to catchment management. Individual workshops based around the latest modelling principles, practices and products will be held during the two-week School and will vary in length from a few hours up to three days.

Over the next few months, CRC staff will be seeking your views as to what specific content should be included in the Catchment Modelling School. We will require broad-based input from the land and water industry to make this important event a success.

You can send your ideas and/or register your interest in learning more about the Catchment Modelling School by contacting David Perry via email: david.perry@eng.monash.edu.au

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Graduate Centre, University of Melbourne
Tuesday 30 September 2003, 9:30am-1:30pm

Emerald, Qld
Thursday 2 October 2003, 10:00am-1:00pm

For more information please visit www.catchment.crc.org.au/news or contact
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tel (07) 3875 7457
fax (07 3875 7459
RRR03@environmentaladvocacy.org

with an interest. All of the emails sent to the list are publicly archived and over time will build into an important resource for information about the use and application of the CHUTE software.

The Catchment Modelling Toolkit
The Catchment Modelling Toolkit web site will continue to develop very quickly over the next twelve months, as many of the CRC's modelling products are made available for downloading from the site. We invite you to become familiar with the site at www.toolkit.net.au and watch our progress!

Bob Keller
River Restoration Program
Monash University
Tel: 03 9905 4946
email: bob.keller@eng.monash.edu.au

David Perry
Communication and Adoption Program
Tel: 03 9905 9600
email: david.perry@eng.monash.edu.au

NB The CRC gratefully acknowledges the kind permission of Dr. John Tilleard to freely use algorithms from the early version of CHUTE and material from the original guidelines.

POSTGRADUATES AND THEIR PROJECTS

Dean Judd

Why would anyone with a job (and salary) they enjoyed throw that away to go back to full time study? They 're mad! In my case yes, though it's nothing to do with the decision to study.

I ended up here when, after eleven years of consulting engineering, I decided it was time for a change. I then thought of all the interesting questions clients had asked about rivers over the years and decided it was about time I came up with a credible answer, hence the PhD.

My original motivation was to contribute something to our knowledge of the behaviour of avulsions, anabranches or anastomosis. Although relatively rare internationally, anabranching rivers are a common, if not dominant, river pattern in large areas of Australia. Moving across the continent, anabranching systems can be found in:

- the coastal rivers of the North West (e.g. the Fitzroy and Durack Rivers),
- the semi-arid rivers of the Northern Plains (e.g. the Marshall and Sandover Rivers),
- the Eyre Basin (e.g. the Diamantina River and Cooper Creek),
- throughout the Riverine Plain of the Murray-Darling Basin (e.g. the Namoi and Ovens Rivers);
- and the coastal rivers east and south of the Great Divide (e.g. the Thomson and Glenelg Rivers).

The characteristics of these rivers vary widely from sand dominated, ridge forming systems (the Durack), semi-arid, mud dominated systems (the Cooper), through to the mixed-load, laterally active rivers across the Murray-Darling.

The tendency for anabranching rivers to be associated with broad floodplains means their effective management is often important to agricultural and economic development. Multiple channels and the breadth and diversity of physical features associated with these can increase the environmental value of anabranching systems. In south-eastern Australia, the rivers of the Murray-Darling have been exploited for the development of transport, agriculture and communities. Increasing recognition of the environmental value of these river systems and the cost of economic development is driving proposals for the rehabilitation of these anabranching systems on a scale not before seen in Australia.

The successful management of the Murray-Darling Basin may be constrained by our current understanding of the evolution of avulsions, anabranches or anastomosing rivers, hence my enthusiasms to address some of these issues.

My first look at the literature told me we hadn't yet agreed on what to call these rivers, let alone on how they behaved. After a few months of literature review, I managed to come up with some interesting and relatively easy research questions to answer about anabranching. Fortunately, though I didn't think so at the time, my supervisors had other ideas. Grudgingly and then enthusiastically, I looked for a way to investigate the holy grail of anabranching - what causes it. Why does a perfectly good river channel divide into two or several different channels? Having found a way to research this - the quest for the grail continues.

At the outset, I hoped I would enjoy doing research. It has in fact been more satisfying and enjoyable than I thought. However, I still have two years to change my mind about that.

Dean Judd
Tel: (03) 9905 5578
Email: dean.judd@eng.monash.edu.au

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or you can contact Virginia Verrelli at the Centre Office on 03 9905 2704.

CRC PROFILE

Our CRC Profile for August is:

Mark Littleboy

Hello. I'm Mark Littleboy and I joined the NSW Department of Infrastructure, Planning and Natural Resources (Formerly Land and Water Conservation) in 1999, based Queanbeyan near Canberra. I am a born and bred Queenslander (nuff said), who much to the disappointment of colleagues here in NSW, couldn't care less about State of Origin football.

I occasionally ponder why I am became a scientist - and maybe others do as well? It all goes back to my childhood, and fun playing with chemistry sets and electronics (even crystal radios). It was more fun than playing with my brother, who ended up as an economist. Then I ponder why I became a computer modeller. This goes back to an article I read in a radical high-tech magazine back in the 70s about the new growth industry called "computer programming". I recall another article in the same magazine dealt with this futuristic new technology which will one day replace the needle stylus on a record player with a laser. They called it a compact disc player.

My original studies were in the School of Environmental Studies at Griffith University. After graduating I spent two years working as Walter Boughton's research assistant in the early 80s and then I left the hallowed halls of the University to join the Queensland Department of Natural Resources (and its many predecessors through numerous name changes and restructures), where I spent 15 years in a variety of work units and project areas. Along the way I picked up an Honours degree (Griffith) and a PhD at the University of Queensland.

In 1999, after (and during) a series of "life-changing" events, I ran away from a 15 year stint in the Qld Department of Natural Resources in Brisbane and joined the NSW Department of Land and Water Conservation in Queanbeyan. To be honest, I didn't actually run away from QDNR, I ran away from "something" else..... but that's another story that cannot be repeated here.

In my previous and rapidly becoming distant and faded life in QDNR, my research focussed on biophysical modelling of land degradation issues. Whether it be soil erosion, soil compaction risk, changes in water balance due to land management, offsite chemical export or sustainable reuse of effluent. In the past, I have also dabbled with a range of other models including groundwater flow, air pollution dispersion, crop and pasture growth, and nutrient balance models.

One highlight of my time in QDNR was a four year involvement in a research project in Central India where extensive field experimentation was conducted to quantify the hydrological effects of different soil management options; many of which were completely different to those used here in Australia. My role was to provide modelling support. Firstly, to validate the PERFECT simulation model against the field data. Secondly, to extrapolate the experimental results in space and time. Thirdly, to provide training and support to Indian scientists in unsaturated zone water balance models.

Back in Australia, and specifically here in Queanbeyan, since joining DIPNR I became suddenly focussed in the area of dryland salinity. In my first major project, I was the poor soul responsible for delivering the NSW component of the Dryland Salinity Theme of the National Land and Water Resources Audit.

I have recently completed a project that predicts changes in soil water balance (particularly recharge) for various land uses using unsaturated zone modelling. A major issue was that water movement in a landscape is not as one-dimensional as most 1-D unsaturated zone models assume. However, many of the current 2-D water balance models are too complex to apply at the geographical scales we must address (from subcatchment, through catchment, to regional to statewide). We captured and quantified the more complex 2-D processes occurring in a landscape and simulated them using simpler models that can be applied at a statewide scale using available datasets.

This recharge modelling work fits into a broader modelling framework currently being developed in DIPNR as part of the State Salinity Strategy. It is intended to expand the modelling work previously applied for the MDBC Salinity Audit to develop a predictive capability to simulate water and salt movement from land use changes in a catchment through to end of basin salt loads.

I also established another NSW Salinity Strategy project called "Recharge Validation" which is supporting five detailed water balance monitoring sites across NSW to support salinity modelling. This project involves three NSW State Agencies and five Universities.

After more than twenty years in science, now I just wonder whether I am still a scientist or a modeller, or just simply another project manager. I suppose project managers are conclusive evidence of human cloning.

Now putting on my CRC for Catchment Hydrology face rather than my DIPNR face. I am the Project Leader of CRC Project 2C: 'Predicting Salt Movement in Catchments' that is developing a consistent salinity modelling framework across eastern Australia. Project Parties are the State NRM Agencies for Qld, NSW and Vic and CSIRO. As part of my CRC role, I spend 50% of my time at CSIRO Black Mountain in Canberra, so I have the luxury of having two offices; one in DIPNR and one at CSIRO. The penalty for this is having to trawl through two email accounts rather than just one.

After four years in Queanbeyan, I must admit that job satisfaction has greatly exceeded my original expectations when I started out. My only disappointment so far has been the scarcity of days I have actually made it to the ski fields this past four winters. That will change this winter! Or what's left of it. But, I said that last winter as well. And the winter before.

But of course, there is an obvious advantage of having offices at both CSIRO and DIPNR when it comes to impromptu day trips to the snow.

On a personal front, of course I am a ski addict, plus enjoy running (when I am motivated enough), bushwalking, golf, drinking (not really, but I have to say that to fit into Queanbeyan culture), reading, gardening and simply enjoying life. And I am looking forward to life in Queanbeyan, after having lived in Brisbane all my life. The country town atmosphere is quite refreshing (so far); plus Canberra is only ten minutes away. I have also learnt to avoid Queanbeyan pubs at night. In my first experience I was physically threatened by a soldier just back from East Timor and in my second, was harassed by a neo-Nazi. Maybe it was something I said?

I have also "taken the plunge" and purchased a house here, which seems to show some sort of long-term commitment to the town. Redecorating rather than renovation has been a major focus these past couple of years, and finally the end is in sight.

And yes! I am surviving the Canberra winters. Actually, I seemed to have acclimatised quickly.

Mark Littleboy
Tel: (02) 6298 4022
Email: mlittleboy@dlwc.nsw.gov.au

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

Print Post Approved
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If undelivered return to:

Department of Civil Engineering
Building 60
Monash University
Vic 3800

SURFACE MAIL

POSTAGE PAID AUSTRALIA

CENTRE OFFICE:
CRC for Catchment Hydrology
Department of Civil Engineering
Building 60 Monash University,
Vic 3800
Telephone: +61 3 9905 2704
Facsimile: +61 3 9905 5033

crcch@eng.monash.edu.au

OUR MISSION

To deliver to resource managers the capability to assess the hydrologic impact of land-use and water-management decisions at whole-of-catchment scale.

OUR RESEARCH

To achieve our mission the CRC has six multi-disciplinary research programs:

- Predicting catchment behaviour
- Land-use impacts on rivers
- Sustainable water allocation
- Urban stormwater quality
- Climate variability
- River restoration

The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Commonwealth CRC Program between:

Brisbane City Council
Bureau of Meteorology
CSIRO Land and Water
Department of Infrastructure, Planning and Natural Resources
Department of Sustainability and Environment, Vic
Goulburn-Murray Water
Griffith University
Melbourne Water
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